Université d'Ottawa · University of Ottawa
Faculté des sciences
Mathématiques et de statistique
Faculty of Science
Mathematics and Statistics

MAT 2379: Final Examination **Questionnaire Booklet**

Professor: **Date:**

Duration: 3 hours

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- **This is a closed book exam. Two sheets (double-sided) are permitted.**
- **Only Faculty standard calculators are permitted.**
- **There are three parts: 12 multiple choice questions, 10 True/False questions and 3 short answer questions.**
- **The exam is out of 55 marks.**

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Multiple Choice Questions (2 marks/question for a total 24 marks)

Please enter your choices in the ANSWER booklet.

1. The systolic blood pressure level in a certain population is approximately equal to the value 125 mm Hg. A topic of recent clinical interest is the fact that extensive use of oral contraceptive (OC) may cause a reduction in the systolic blood pressure under the value 125. A study is organized to test this hypothesis. The n women who participated in this study used OC for a period of 3 months. At the end of the study, their systolic blood pressure was measured. The summary of the data and the *R* output of the test are given below. We deleted the number of degrees of freedom.

```
> mean(x)
[1] 120.4
> sd(x)
[1] 13.23
> t.test(x,mu=125,alternative="less")

        One Sample t-test

data:  x
t = -1.0998, df =-, p-value = 0.15
alternative hypothesis: true mean is less than 125
95 percent confidence interval:
    -Inf 128.067
sample estimates:
mean of x
    120.4
```

What was the number n of participants in this study?

A) 12 B) 40 C) 10 D) 32 E) 25

2. The plant-water relation plays an important role in plant physiology. We consider an experiment in which 16 seedlings of birch tree were flooded with water for one day and 13 other seedlings were kept as controls. At the end of the experiment, the roots of all plants were analyzed for the level of adenosine triphosphate (ATP), as a measure for the intracellular energy transfer. Below is the summary of the data:

	flooded plants	control plants
sample size	$n_1 = 16$	$n_2 = 13$
sample mean	$\bar{x}_1 = 1.17$	$\bar{x}_2 = 1.91$
sample standard deviation	$s_1 = 0.16$	$s_2 = 0.23$

Give a 90% confidence interval for the difference $\mu_1 - \mu_2$, where μ_1 is the average ATP level for the flooded plants and μ_2 is the average ATP level for the controls. Based on this interval, can we conclude that flooding causes a decrease or an increase in the ATP level? (Assume that the ATP levels for flooded plants and controls are normally distributed with equal variances.)

A) [0.5673; 0.7614]; flooding causes an increase in the mean ATP level
B) [0.4532; 0.6719]; flooding causes an increase in the mean ATP level
C) [-0.6182; -0.4820]; flooding causes a decrease in the mean ATP level
D) [-0.8635; -0.6165]; flooding causes a decrease in the mean ATP level
E) [-0.0346; 0.3471]; we cannot conclude that flooding causes a decrease or an increase in the mean ATP level

3. The following data gives the number of deadly bear attacks in North America per decade, for the 9 decades between 1900 and 1988:

$$2,\ 1,\ 4,\ 8,\ 6,\ 9,\ 9,\ 19,\ 20.$$

Calculate the mean and standard deviation for the number of deadly bear attacks in North America per decade.

A) The mean is 8.667 and the standard deviation is 5.6505.
B) The mean is 8.0 and the standard deviation is 19.0.
C) The mean is 8.0 and the standard deviation is 5.0.
D) The mean is 8.667 and the standard deviation is 46.0.
E) The mean is 8.667 and the standard deviation is 6.7823.

4. A team of researchers have studied the effect of reminiscence therapy on old women suffering from depression. The researchers have measured the depression level (on a scale from 1 to 10) for 20 women of age 60+ who have stayed for at least 3 months in a long-term care facility. On this scale, a high depression level is interpreted as severe depression. For each of the 20 women, the depression level was measured before and after the reminiscence therapy. Using the data from this study, we created in R the variables `before` and `after`, which contain the depression levels for the 20 women, before and after the therapy, respectively. We also calculated the difference `d` between the depression level after the therapy and the depression level before the therapy, for each women. Below is the R output which gives the summary for these differences.

```
> d=after-before
> summary(d)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  -5.00   -3.00   -0.50   -1.35    0.00    1.00
> sd(d)
[1] 2.084403
```

Suppose that the difference between the depression level after the therapy and the depression level before the therapy is normally distributed. Using the above summary, calculate a 95% confidence interval (c.i.) for the mean difference μ_D between the depression level after the therapy and the depression level before the therapy. Based on this confidence interval, are we confident that on average, the depression is less severe after the therapy?

A) c.i.=$[0.37; 2.33]$. We are confident that the depression is more severe after the therapy, on average.
B) c.i.=$[-2.33; 0.37]$. There is not enough evidence that the depression is less severe after the therapy, on average.
C) c.i.=$[-2.53; -0.57]$. We are confident that the depression is less severe after the therapy, on average.
D) c.i.= $[-2.33; -0.37]$. We are confident that the depression is less severe after the therapy, on average.
E) c.i.=$[-2.33; -0.37]$. There is not enough evidence that the depression is less severe after the therapy, on average.

5. An experimental cancer vaccine has been developed to reduce the tumor size. We would like to test the null hypothesis that the vaccine has no effect on the tumor size, against the alternative hypothesis that the vaccine is effective in reducing the tumor size. Denote by μ_D the mean difference between the tumor size before the vaccine and the tumor size 3 months after the vaccine. Set-up a test of hypotheses and explain when type I error or type II error occur by choosing the correct statement from the list below. (Only one statement is correct.)

   A) $H_0 : \mu_D = 0$ versus $H_1 : \mu_D > 0$. Type II error occurs when we decide that the vaccine is effective in reducing the tumor size, when in fact it is not.
   B) $H_0 : \mu_D = 0$ versus $H_1 : \mu_D < 0$. Type I error occurs when we decide that vaccine is effective in reducing the tumor size, when in fact it is not.
   C) $H_0 : \mu_D = 0$ versus $H_1 : \mu_D > 0$. Type I error occurs when we decide that the vaccine is not effective in reducing the tumor size, when in fact it is.
   D) $H_0 : \mu_D = 0$ versus $H_1 : \mu_D \neq 0$. Type I error occurs when we decide that the vaccine is effective in reducing the tumor size, when in fact it is not.
   E) $H_0 : \mu_D = 0$ versus $H_1 : \mu_D > 0$. Type II error occurs when we decide that the vaccine is not effective in reducing the tumor size, when in fact it is.

6. The blood types have the following distribution: 41% O, 31% A, 22% B and 6% AB. It is known that O is a universal donor, A can donate only to A and AB, B can donate only to B and AB, and AB can donate only to AB. If a patient who needs a blood transfusion receives blood from a randomly selected donor, and the two persons are independent of each other, what is the probability that the transfusion is successful?

   A) 0.6607 B) 0.3393 C) 0.4101 D) 0.7314 E) 0.5899

7. A pharmaceutical company is testing a new analgesic (medication for pain relief) on a sample of 6 patients suffering from migraine. Among these, 4 patients reported that their migraines disappeared after using the drug. However, it is known that 20% of migraines disappear anyways without any treatment. What is the probability that in a sample of 6 patients suffering from migraine, the migraines will disappear without any treatment for exactly 4 them?

A) 0.0016 B) 0.2534 C) 0.3523 D) 0.0154 E) 0.9992

8. The average length of human gestation is approximately 40.5 weeks. It is thought that maternal diabetes may influence the length of the gestation. In a study consisting of 20 diabetic pregnant women, it was found that the mean gestation period was 38.8 weeks with a standard deviation of 5 weeks. Is there enough evidence that the length of gestation in diabetic women is significantly different than the value of 40.5 weeks? Use an appropriate test of hypotheses of level $\alpha = 0.05$. Report the range of the p-value and the conclusion of the test.

A) The p-value is between 0.01 and 0.025. The mean length of gestation for diabetic women is significantly different than 40.5.
B) The p-value is between 0.025 and 0.05. The mean length of gestation for diabetic women is significantly different than 40.5.
C) The p-value is between 0.05 and 0.10. There is not enough evidence that the mean length of gestation for diabetic women is significantly different than 40.5.
D) The p-value is between 0.10 and 0.20. There is not enough evidence that the mean length of gestation for diabetic women is significantly different than 40.5.
E) The p-value is between 0.20 and 0.40. There is not enough evidence that the mean length of gestation for diabetic women is significantly different than 40.5.

9. Approximately 4% of men with age between 40 and 55 years will have a heart attack in a 5-year period. A new drug was developed to reduce the probability of having a heart attack for men in this age group. A 5-year study was conducted involving men in this age group who have been treated with the new drug. Among the 2046 participants in the study, 56 had a heart attack within the 5-year period. Let p be the proportion of men in the age group 40-55 using this drug who will have a heart attack. Give a 95% confidence interval (c.i.) for p. Using this interval, can we conclude that the new drug is efficient in reducing the risk of having a heart attack for men in this age group?

   A) c.i.=[0.020; 0.034]. The new drug is not efficient.
   B) c.i.=[0.020; 0.034]. The new drug is efficient.
   D) c.i.=[0.014; 0.041]. The new drug is efficient.
   D) c.i.=[0.041; 0.052]. The new drug is not efficient.
   E) c.i.=[0.020; 0.056]. Using this data, we cannot draw any conclusion about the efficiency of the new drug.

10. Continue with the situation in Problem 9. Formulate a null hypothesis H_0 and an alternative hypothesis H_1 which could be used for testing that the new drug is efficient in reducing the risk of having a heart attack for men in this age group. Calculate the p-value of this test.

   A) $H_0 : p = 0.04$ against $H_1 : p > 0.04$. The p-value is 0.9982.
   B) $H_0 : p = 0.04$ against $H_1 : p < 0.04$. The p-value is 0.0036.
   C) $H_0 : p = 0.04$ against $H_1 : p < 0.04$. The p-value is 0.0018.
   D) $H_0 : p = 0.04$ against $H_1 : p \neq 0.04$. The p-value is 0.0036.
   E) $H_0 : p = 0.04$ against $H_1 : p < 0.04$. The p-value is 0.0154.

11. Scientists studied the relationship between the length of a body of a bullfrog and how far it can jump. Eleven bullfrogs were included in the study. For each bullfrog, we computed x, which is the length of its body (in mm) and we computed y, which is its maximum jump (in cm). We assigned the data to the variable `x` and `y` in `R`. We computed a few descriptive statistics.

```
> summary(x)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  127.0   136.0   155.0   149.6   160.0   172.0
> summary(y)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   70.0   101.6   109.2   104.0   115.0   122.9
> sd(x)
[1] 14.47254
> sd(y)
[1] 17.94154
```

We also computed the following sum

$$\sum_{i=1}^{11}(y_i - \overline{y})(x_i - \overline{x}) = 731.3636,$$

with the following command.

```
> sum((y-mean(y))*(x-mean(x)))
[1] 731.3636
```

Let $\widehat{y} = \hat{\alpha} + \hat{\beta}\, x$ be the least square line of the maximum jump expressed as a function of the length of the body. Give the value of the slope $\hat{\beta}$.

A) 0.3491 B) 3.4918 C) 50.5345 D) -2.5345 E) 0.1567

12. Consider two samples from independent normal populations with respective means $\mu_1 = 23$ and $\mu_2 = 45$. The populations have equal variances. Let $\overline{X}_1$ and $\overline{X}_2$ be the respective samples means. Let S_p be the pooled sample standard deviation. Assuming that the sample sizes are $n_1 = n_2 = 15$, then find the value of b such that

$$P\left(\frac{(\overline{X}_1 - \overline{X}_2) - (-22)}{S_p\sqrt{2/15}} > b\right) = 0.975.$$

A) 2.048 B) -2.048 C) 2.042 D) -2.042 E) -2.045

True or False Questions (0.5 mark/question for a total of 5 marks)

Use your knowledge to identify the veracity of the following statements. If you think a statement is true, circle "TRUE" in the corresponding spot of the answer booklet; if you think a statement is false or there is insufficient information to determine its veracity, circle "FALSE" in the corresponding spot of the ANSWER booklet.

1. An event is a subset of the sample space.

2. Let A and B be two events. $(A \cup B)' = A' \cap B'$.

3. Let A and B be two events with $P(A) > 0$ and $P(B) > 0$. $P(A|B) = P(B|A)$.

4. Let A and B be two events. If $P(A) = 0$, A and B are independent with each other.

5. Let X be the number of successes in a series of n "success/failure" trials, each with a success probability p. Then, X follows a binomial distribution with the number of trials n and success rate p.

6. Suppose X follows a normal distribution with mean 3 and variance 4. $P(X \leq 1) = 1 - P(X < 5)$.

7. Compared with sample mean, sample median is less sensitive to extreme values.

8. Let $x_1, \ldots, x_n$ be a random sample of size n of a numerical variable x. Let $\max(x)$ be the maximum value in the sample. We apply the log-transformation to these data: $y_i = \ln(x_i)$ for $i = 1, 2, 3, \ldots, n$. Let $\max(y)$ be the maximum value of the log-transformed values. Then, $\max(y) = \ln(\max(x))$.

9. Let X be a population of interest with mean $E(X) = \mu$. A random sample $\{x_1, \ldots, x_n\}$ is collected and a 95% confidence interval for μ is computed as $[-1.5, 2.2]$. This means that $P(-1.5 \leq \mu \leq 2.2) = 0.95$.

10. In hypothesis testing, a small p-value is interpreted as strong evidence against the null hypothesis.

Short answer questions (total of 26 marks)

Please enter your complete answers in the ANSWER booklet.

Question 1 [6 points]: For men, binge drinking is defined as having five or more drinks in a row, and for women as having four or more drinks in a row. (The difference is because of the average difference in weight.) According to a particular study 41% of university students engage in binge drinking, 59% drink moderately or abstain entirely. Furthermore, among the binge drinkers 23% have been involved in an alcohol-related auto- mobile accident, while among moderate or non drinkers, only 6% have been involved in such accidents. Suppose that we select a university at random.

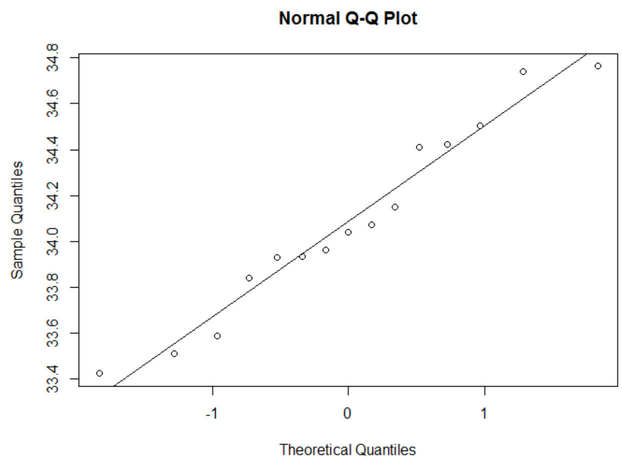
(a) What is the probability that the student was involved in an alcohol-related automobile accident?

(b) If the student was involved in an alcohol-related automobile accident, what is the probability that this student is a binge drinker?

Question 2: [13 points] For each child in a sample of size $n = 15$, we measured their head circumference at birth (in cm). We assigned the 15 values to the numerical variable `x` in `R`. Here are some descriptive statistics.

```
> summary(x)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  33.42   33.89   34.04   34.09   34.42   34.76
> sd(x)
[1] 0.4156212
```

(a) Below is a quantile-quantile plot for the circumference at birth of the 15 infants. We use this plot to assess which assumption? What are your findings?



(b) Using a hypothesis test to verify a claim that the mean circumference of the head at birth is less than 34.5 cm. Formulate your hypotheses. Give the observed value of the test statistic. Give the sampling distribution of the test statistic assuming that the null hypothesis is true. Give your conclusion at a level of significance of 5%.

(c) Consider your conclusion from part (c). If you committed an error, is it a type I error or a type II error? (Discuss.)

(d) Give a 95% confidence interval for the mean circumference of the head at birth.

Question 3: [**7 points**] We collected data for the length of life, in seconds, of fruit flies subject to a new spray in a controlled laboratory experiment. We imported the data into `R` and produced the following output.

```
> table = read.table(file.choose(),header=TRUE,sep="\t")
> names(table)
[1] "life.in.seconds"
> x=table$life.in.seconds
> summary(x)
Min. 1st Qu. Median  Mean 3rd Qu.   Max.
3.00    7.25  10.50 12.32   15.75  32.00
```

```
> summary(log(x))
  Min. 1st Qu. Median  Mean 3rd Qu.  Max.
 1.099   1.979  2.350 2.395   2.756 3.466
> length(x)
[1] 50
```

(a) For the variable length of time (measured in seconds), are there any outliers? (Why?)

(b) For the logarithm of the length of time, are there any outliers? (Why?)

(c) Give the mean and the geometric mean of the length of time (measured in seconds).

(d) Suppose that we want the statistics in minutes instead of seconds. Give the inter-quartile range for the length of time (measured in minutes).

Cumulative distribution function for $N(0,1)$: $\Phi(z) = P(Z \leq z)$

0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.02	0.01	0.00	z
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	−3.8
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	−3.7
.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0002	.0002	−3.6
.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	−3.5
.0002	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	−3.4
.0003	.0004	.0004	.0004	.0004	.0004	.0004	.0005	.0005	.0005	−3.3
.0005	.0005	.0005	.0006	.0006	.0006	.0006	.0006	.0007	.0007	−3.2
.0007	.0007	.0008	.0008	.0008	.0008	.0009	.0009	.0009	.0010	−3.1
.0010	.0010	.0011	.0011	.0011	.0012	.0012	.0013	.0013	.0013	−3.0
.0014	.0014	.0015	.0015	.0016	.0016	.0017	.0018	.0018	.0019	−2.9
.0019	.0020	.0021	.0021	.0022	.0023	.0023	.0024	.0025	.0026	−2.8
.0026	.0027	.0028	.0029	.0030	.0031	.0032	.0033	.0034	.0035	−2.7
.0036	.0037	.0038	.0039	.0040	.0041	.0043	.0044	.0045	.0047	−2.6
.0048	.0049	.0051	.0052	.0054	.0055	.0057	.0059	.0060	.0062	−2.5
.0064	.0066	.0068	.0069	.0071	.0073	.0075	.0078	.0080	.0082	−2.4
.0084	.0087	.0089	.0091	.0094	.0096	.0099	.0102	.0104	.0107	−2.3
.0110	.0113	.0116	.0119	.0122	.0125	.0129	.0132	.0136	.0139	−2.2
.0143	.0146	.0150	.0154	.0158	.0162	.0166	.0170	.0174	.0179	−2.1
.0183	.0188	.0192	.0197	.0202	.0207	.0212	.0217	.0222	.0228	−2.0
.0233	.0239	.0244	.0250	.0256	.0262	.0268	.0274	.0281	.0287	−1.9
.0294	.0301	.0307	.0314	.0322	.0329	.0336	.0344	.0351	.0359	−1.8
.0367	.0375	.0384	.0392	.0401	.0409	.0418	.0427	.0436	.0446	−1.7
.0455	.0465	.0475	.0485	.0495	.0505	.0516	.0526	.0537	.0548	−1.6
.0559	.0571	.0582	.0594	.0606	.0618	.0630	.0643	.0655	.0668	−1.5
.0681	.0694	.0708	.0721	.0735	.0749	.0764	.0778	.0793	.0808	−1.4
.0823	.0838	.0853	.0869	.0885	.0901	.0918	.0934	.0951	.0968	−1.3
.0985	.1003	.1020	.1038	.1056	.1075	.1093	.1112	.1131	.1151	−1.2
.1170	.1190	.1210	.1230	.1251	.1271	.1292	.1314	.1335	.1357	−1.1
.1379	.1401	.1423	.1446	.1469	.1492	.1515	.1539	.1562	.1587	−1.0
.1611	.1635	.1660	.1685	.1711	.1736	.1762	.1788	.1814	.1841	−0.9
.1867	.1894	.1922	.1949	.1977	.2005	.2033	.2061	.2090	.2119	−0.8
.2148	.2177	.2206	.2236	.2266	.2296	.2327	.2358	.2389	.242	−0.7
.2451	.2483	.2514	.2546	.2578	.2611	.2643	.2676	.2709	.2743	−0.6
.2776	.2810	.2843	.2877	.2912	.2946	.2981	.3015	.3050	.3085	−0.5
.3121	.3156	.3192	.3228	.3264	.3300	.3336	.3372	.3409	.3446	−0.4
.3483	.3520	.3557	.3594	.3632	.3669	.3707	.3745	.3783	.3821	−0.3
.3859	.3897	.3936	.3974	.4013	.4052	.4090	.4129	.4168	.4207	−0.2
.4247	.4286	.4325	.4364	.4404	.4443	.4483	.4522	.4562	.4602	−0.1
.4641	.4681	.4721	.4761	.4801	.4840	.4880	.4920	.4960	.5000	−0.0

Cumulative distribution function for $N(0,1)$: $\Phi(z) = P(Z \leq z)$

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998
3.5	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998	.9998
3.6	.9998	.9998	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999
3.7	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999
3.8	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999	.9999

The T distribution with ν degrees of freedom

	$F_T(t) = P(T \leq t)$						
	.6	.75	.9	.95	.975	.99	.995
ν	$t_{.40,\nu}$	$t_{.25,\nu}$	$t_{.10,\nu}$	$t_{.05,\nu}$	$t_{.025,\nu}$	$t_{.01,\nu}$	$t_{.005,\nu}$
1	0.325	1.000	3.078	6.314	12.706	31.821	63.657
2	0.289	0.816	1.886	2.920	4.303	6.965	9.925
3	0.277	0.765	1.638	2.353	3.182	4.541	5.841
4	0.271	0.741	1.533	2.132	2.776	3.747	4.604
5	0.267	0.727	1.476	2.015	2.571	3.365	4.032
6	0.265	0.718	1.440	1.943	2.447	3.143	3.707
7	0.263	0.711	1.415	1.895	2.365	2.998	3.499
8	0.262	0.706	1.397	1.860	2.306	2.896	3.355
9	0.261	0.703	1.383	1.833	2.262	2.821	3.250
10	0.260	0.700	1.372	1.812	2.228	2.764	3.169
11	0.260	0.697	1.363	1.796	2.201	2.718	3.106
12	0.259	0.695	1.356	1.782	2.179	2.681	3.055
13	0.259	0.694	1.350	1.771	2.160	2.650	3.012
14	0.258	0.692	1.345	1.761	2.145	2.624	2.997
15	0.258	0.691	1.341	1.753	2.131	2.602	2.947
16	0.258	0.690	1.337	1.746	2.120	2.583	2.921
17	0.257	0.689	1.333	1.740	2.110	2.567	2.898
18	0.257	0.688	1.330	1.734	2.101	2.552	2.878
19	0.257	0.688	1.328	1.729	2.093	2.539	2.861
20	0.257	0.687	1.325	1.725	2.086	2.528	2.845
21	0.257	0.686	1.323	1.721	2.080	2.518	2.831
22	0.256	0.686	1.321	1.717	2.074	2.508	2.819
23	0.256	0.685	1.319	1.714	2.069	2.500	2.807
24	0.256	0.685	1.318	1.711	2.064	2.492	2.797
25	0.256	0.684	1.316	1.708	2.060	2.485	2.787
26	0.256	0.684	1.315	1.706	2.056	2.479	2.779
27	0.256	0.684	1.314	1.703	2.052	2.473	2.771
28	0.256	0.683	1.313	1.701	2.048	2.467	2.763
29	0.256	0.683	1.311	1.699	2.045	2.464	2.756
30	0.256	0.683	1.310	1.697	2.042	2.457	2.750
∞	0.253	0.674	1.282	1.645	1.96	2.326	2.576

Note: $z_\alpha = t_{\alpha,\infty}$